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COMMENTARY

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Advancing research on alien species and biological invasions

Invasive alien species add to the uncertain future of protected areas

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In a recent article on "The uncertain future of protected lands and waters", Golden Kroner et al. (2019) suggest that legal changes that temper the regulations in protected areas (PAs) are one of the main threats to biodiversity conservation. By examining Protected Area Downgrading (i.e. relaxing restrictions), Downsizing (i.e. shrinking boundaries) and Degazettement (i.e. complete loss of protection) (in total referred to as PADDD) over the last 126 years, they assessed the factors leading to PADDD events and discuss their consequences for the conservation of PAs in the United States and Amazonian countries. They conclude that most PADDD events were associated with industrial-scale resource extraction and local land pressure and land claims. To mitigate these trends, they recommend increasing research efforts to support evidence-based conservation policies to address the challenges of PADDD. However, they overlook one of the largest threats to conservation and PAs in particular – biological invasions (Foxcroft et al. 2013, 2017). Potentially, invasive alien species (IAS) could be a primary

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cause of enacting a PADDD event (e.g. relaxing restrictions due to IAS-induced habitat transformation). Additionally, while some of the causes of PADDD events stated in the paper centre on conservation planning, forestry, industrial agriculture and mining, IAS can be directly or indirectly associated with all of these. Here, we argue that overlooking the problems associated with IAS in PAs can hinder conservation actions, create biases in the prioritisation of natural resource management and generate false or distorted perceptions for the public.

Globally, the frequency and magnitude of alien species' introductions are changing more rapidly at present than ever before (Seebens et al. 2017) and despite efforts to conserve biodiversity, it is becoming increasingly evident that current approaches and strategies are not sufficient in addressing the scale of biodiversity loss caused by IAS (Le Roux et al. 2019). Consequently, IAS were listed amongst the major drivers of biodiversity loss in the recent Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report (Brondizio et al. 2019); over the last 100 years, an exponential increase in IAS has caused a decrease in the average abundance of native plants, animals and insects by at least one-fifth across many ecosystems. To list some specific examples, a report by the Global Invasive Species Program (De Poorter 2007) identified 487 PAs globally, in which invasive alien plants represented a threat to biodiversity. In Europe, PA managers perceived invasive plants as the second greatest threat to PAs following habitat fragmentation (Pyšek et al. 2013).

In the USA, one of the regions Golden Kroner et al. (2019) used to illustrate their ideas, alien plants were estimated to cover 7.3 million ha across 218 national parks (Allen et al. 2009) and 61% of the 246 park managers indicated that alien plant invasions were of moderate or major concern (Randall 2011). If we compare the numbers of native and alien plant species across 183 PAs in the United States (Figure 1; Suppl. material l: Table S1), there is a large variation in the numbers of alien plants, but they are present in all PAs. Moreover, 87% of these 183 PAs have recently undergone a PADDD event (i.e. downgrade and/or downsize; PADDDtracker.org, 2019) and most of them contain high numbers of alien plants. For example, the proportion of alien plants in the Hawai'i Volcanoes National Park is as high as 61% of the total flora (Loh et al. 2014). The park also contains 12 alien mammals and 37 alien bird species, of which 13 are common breeders (https://irma.nps.gov/NPSpecies, accessed August 2019), including the widespread Japanese white-eye (*Zosterops japonicus*), a vector of introduced avian malaria, a disease widely decimating native bird populations (van Riper III et al. 1986).

Unfortunately, PADDD events are inevitable because they are driven by human development (e.g. mining, forestry, agriculture, urbanisation, oil and gas extraction). The above examples imply that when future PADDD events are proposed, the effects of IAS need to be carefully considered. We believe that in PAs containing IAS that are subjected to PADDD events, there is a higher probability that IAS will have significant causal environmental and socioeconomic effects (Vilà and Hulme 2017; Mazza and Tricarico 2018), especially after degazettement. Consequently, if it is necessary to enact a PADDD, then IAS must be considered in the processes and policies governing these events.

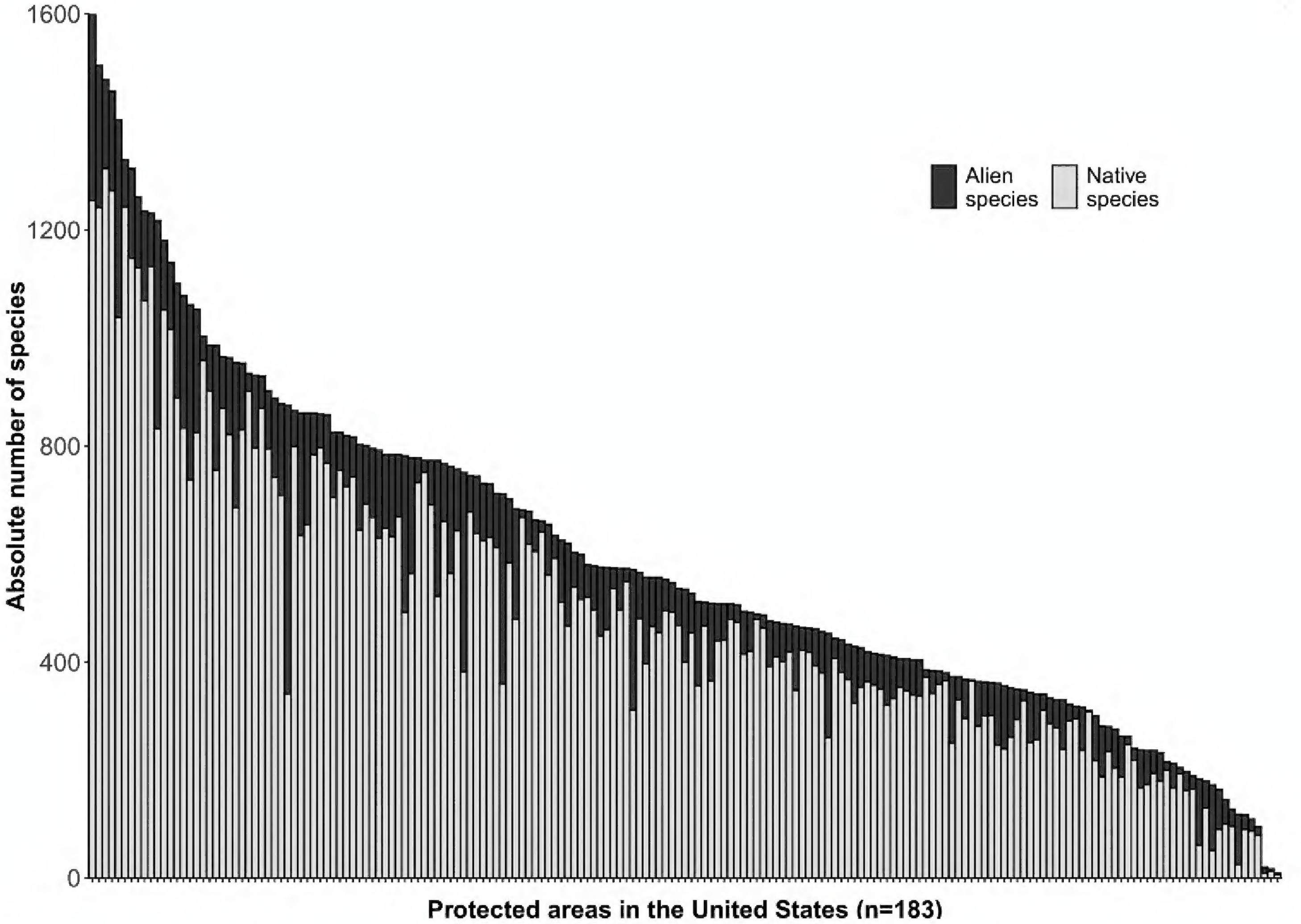

Figure 1. The total number of native and alien plant species recorded across 183 protected areas in the United States (see Suppl. material 1: Table S1 for the park names). Data were derived from the IRMA portal (https://irma.nps.gov/NPSpecies, accessed May 2018).

Disregarding IAS when addressing PADDD can compromise the conservation of PAs. For example, in PAs that already comprise alien species, downgrading can increase the probability of their establishment and spread, downsizing exacerbates habitat fragmentation (Golden Kroner et al. 2016) and degazettement can create ideal settings for IAS to spread after conservation measures have ceased. As such, if PAs are to maintain their integrity and efficacy, we need to explicitly consider the multiple interacting drivers (see van Wilgen and Herbst 2017) causing biodiversity loss in these landscapes, particularly if these drivers are exacerbated through regulatory changes (such as PADDD events). We are also fully aware of the knowledge gap that exists regarding PADDD events and their impacts, therefore we emphasise why it is crucial to consider these major drivers. Overlooking the impact of IAS on PAs can misinform stakeholders such as the general public, decision-makers, funding agencies and managers and can affect research needs.

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Supplementary material 1

Table S1. A list of protected areas (n = 183) in the United States

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